POWER PLANT

ENGINEERING REPORT NO. 3A

(Revised)

STANDARD FIRE TEST APPARATUS AND PROCEDURE

(For Flexible Hose Assemblies)

Prepared by:

Propulsion Branch

Engineering & Manufacturing Division

Revision 3A Prepared by:

E. P. Burke

Revision 3A Approved by:

T. G. Horeff

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STANDARD FIRE TEST APPARATUS AND PROCEDURE

(For Flexible Hose Assemblies)

Standard Fire Test Apparatus and Procedure

This method of test is intended to determine the fire resistance of flexible hose assemblies under simulated conditions. The test is aimed at producing a typical aircraft powerplant fire, vibration of the type encountered during rough engine operation, and the various flight conditions of fluid flow, pressure, and temperature.

The fire test apparatus described in Appendix I of this report, or equivalent equipment, shall be used for determining fire resistance. The main components of this apparatus are:

a. Burner: See Appendix III
b. Vibrating mechanism.
c. Bench.
d. Hood.
e. Temperature measurement and recording.
f. Oil circulator and heater.

The flame produced by the burner shall be calibrated by means of the standardization device and method described in Appendix II and shall have a minimum B. t. u. value of 4500 B. t. u. per hour.

The length of hose assembly to be tested shall be not less than 24-inches. The hose shall be mounted horizontally on the test bench (see figure 1) and shall include one full 90° bend. The hose assembly shall be located inside of the hood except when limited by physical characteristics such as recommended minimum bend radius. The nearest surface of the hose is to be located 4 inches beyond the burner barrel extension. SAE 20 oil at a temperature of not less than 200°F. shall be circulated through the hose assembly and system to remove all air from the piping system and to establish the required operating temperature. The oil flow rate and pressure parameters specified in the applicable Technical Standard Order (TSO) shall be established and maintained during the test. The vibrating mechanism shall then be started and the assembly checked to make certain that no resonant whipping occurs. The fan which affects the air movement over the assembly shall be started. The actual fire test is then begun by igniting the burner and starting the chronometer simultaneously. A satisfactory and convenient means of accomplishing this is by use of the control panel shown in figure 2.

A hose assembly is considered acceptable if it complies with the test conditions and parameters for the time period specified in the TSO without any evidence of leakage. Leakage shall be detected by visual observation from a distance of not more than five feet, at a position where the specimen, flame, and drip pan are visible.

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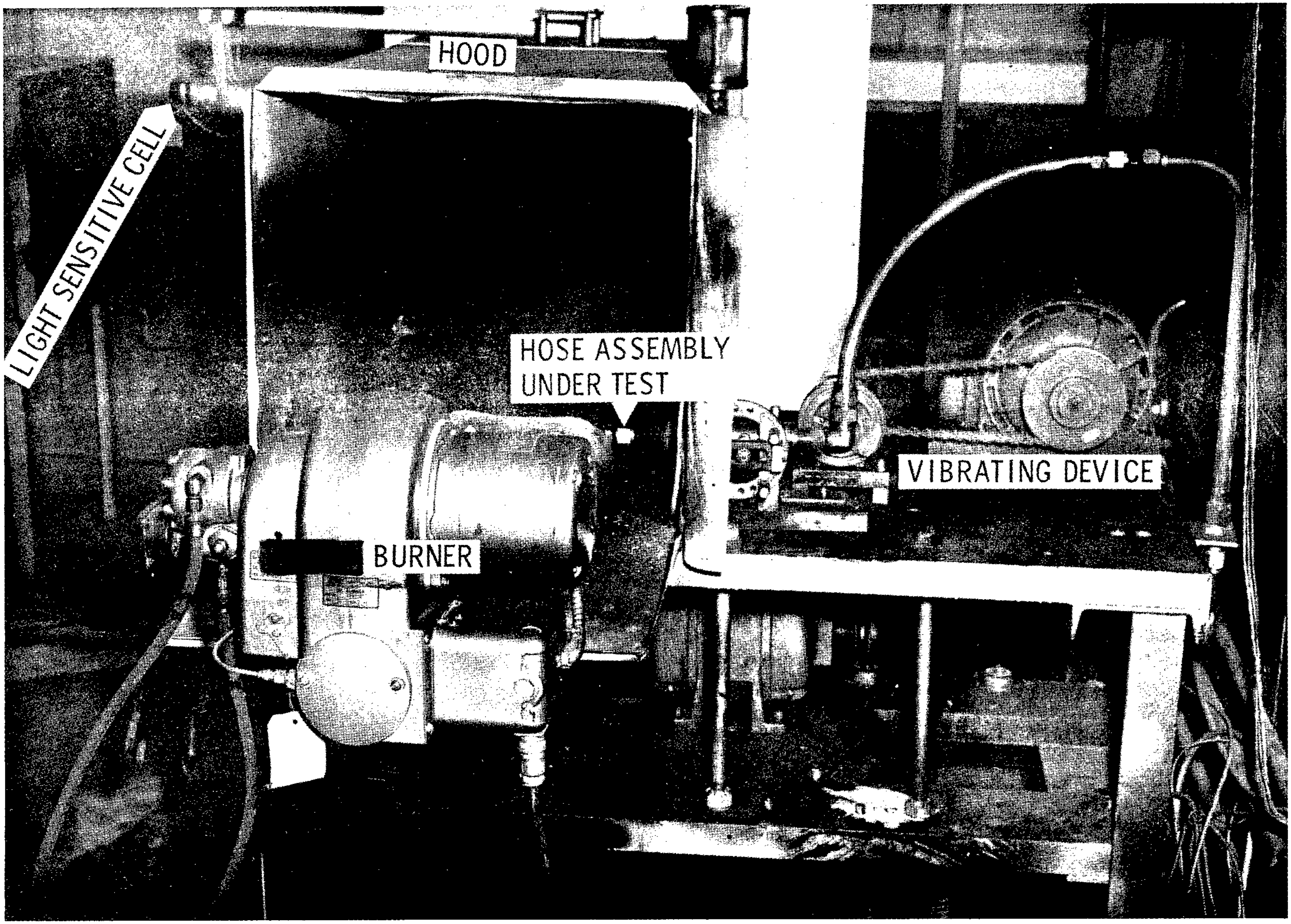

FIGURE I. HOSE ASSEMBLY TEST BENCH

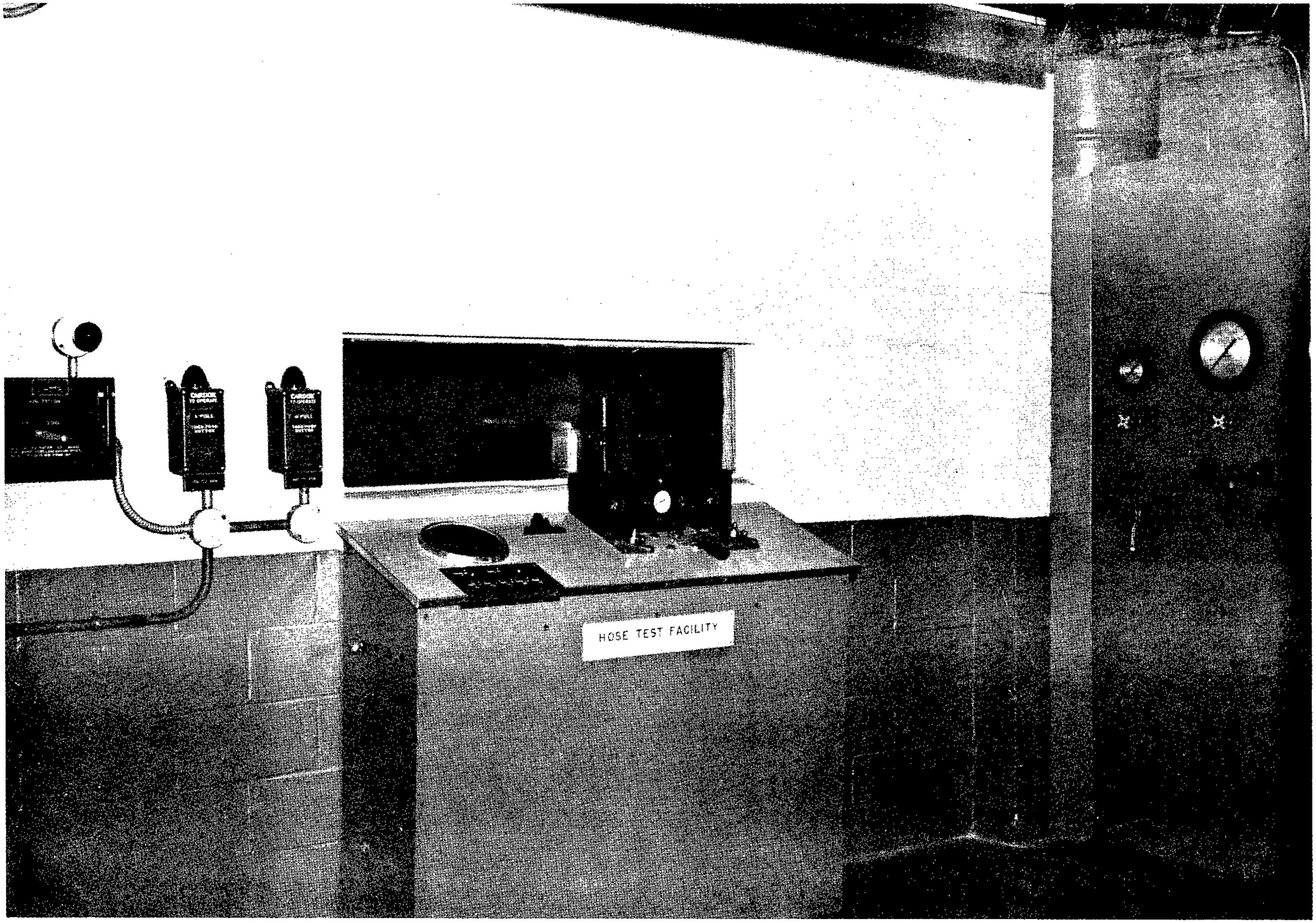

FIGURE 2. HOSE TEST CONTROL PANEL

APPENDIX I

Description of Test Apparatus

TEST BURNER - The burner used to produce the flame shall be a modified gun-type conversion oil burner as described in Appendix III or equivalent. With the oil delivery rate at 2 gallons per hour, adjust the inlet air to achieve the controlling characteristics of the flame (see Appendix III). The portion of the flame in which the hose assembly is to be tested should deliver a minimum heat output of 4500 B. t. u. per hour. Because slight variations in the air pressure as determined by the manometer readings will produce a marked variation in the flame B. t. u. output, it may be necessary to vary the air pressure slightly to obtain the required rate of heat transfer.

VIBRATING MECHANISM - The vibrating mechanism is shown in Figure 1. One end of the hose assembly shall be subjected to a total lateral or longitudinal displacement of not less than 1/8 inch (1/16 inch on each side of normal) at 2000 c.p.m. The vibrated end of the hose assembly shall be subjected to the flame. The vibrating fixture shall be as light as possible to avoid excessive heat transfer or loss through the fixture.

BENCH - The bench consists essentially of a steel table, 60 inches wide, 28 inches deep, and 32 inches high. Mounted on this bench is the vibrating mechanism and a hood.

HOOD - The hood (see figure 1) is 25 inches wide and 25 inches high. The vibrated fitting is located 7 inches back of the open front of the hood. The rear end of the hood is ducted to a fan, which draws air through the hood opening at a velocity of 400 f. p.m. as measured by an Alnor velometer located at the hose assembly specimen. This air movement aids in keeping the flame horizontal and in exhausting fumes.

TEMPERATURE MEASUREMENT AND RECORDING - The temperature sensing system including the thermocouples and indicator shall have an allowable overall error of $\pm$ 1 (one) percent at 2000°F. The flame temperature shall be measured four inches from the end of the burner barrel extension. A sufficient number of the thermocouples shall be used to assure that the specified temperature exists at least along the entire end fitting and the hose for a distance of not less than five inches.

OIL CIRCULATOR AND HEATER - The oil circulating and heating equipment consists of an electrically driven oil pump and an oil tank with a thermostatically controlled immersion heater. The plumbing of the oil system also includes pressure relief valves, flow indicators, pressure gages, and control and selector valves.

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After the warmup period, the temperatures indicated by the inlet and outlet thermometers are recorded every 1/2-minute during a 3-minute period. The average difference in temperature (°F.) of the inlet and outlet water multiplied by the rate of the water flow (500 pounds per hour) equals the rate of B.t.u. increase of the water flowing through the device, and this value is an indication of the severity of the portion of the flame in which hose assemblies are tested.

In addition to these general procedures, those specific procedures called for in TSO-C42, Propeller Feathering Hose Assemblies and TSO-C53a, Fuel Engine Oil System Hose Assemblies shall be followed as applicable.

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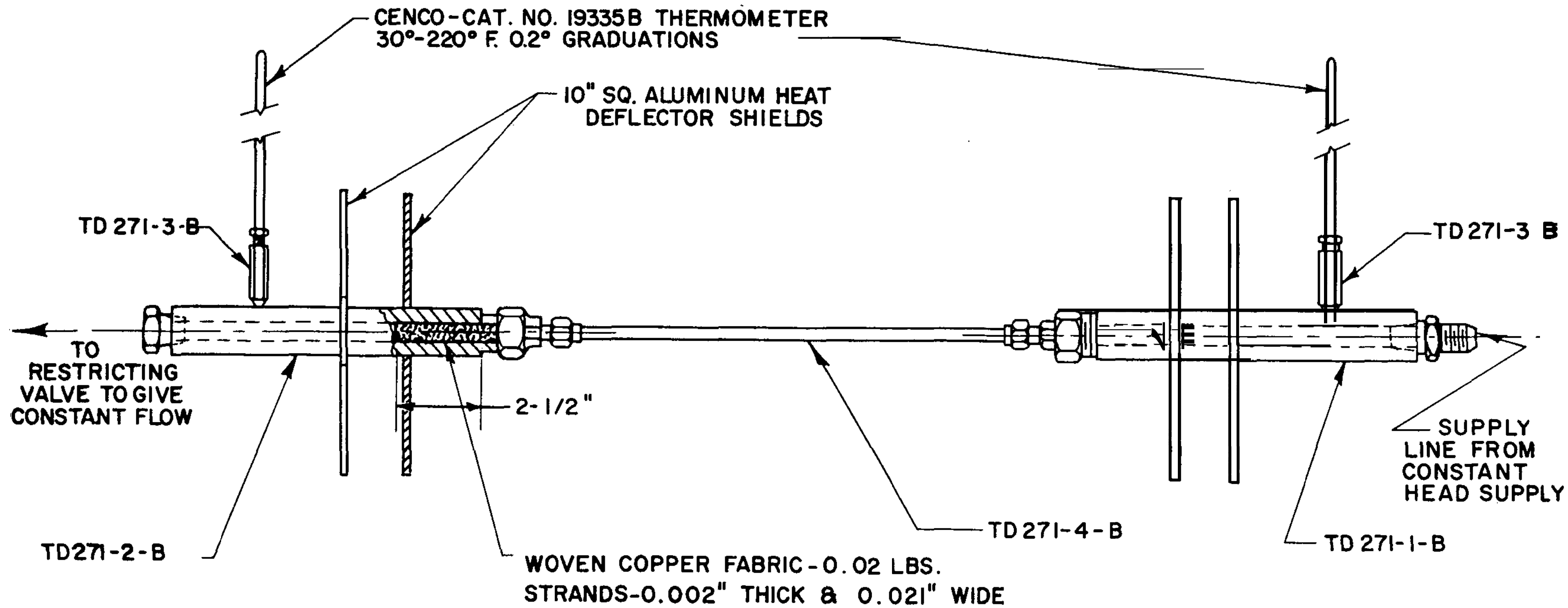
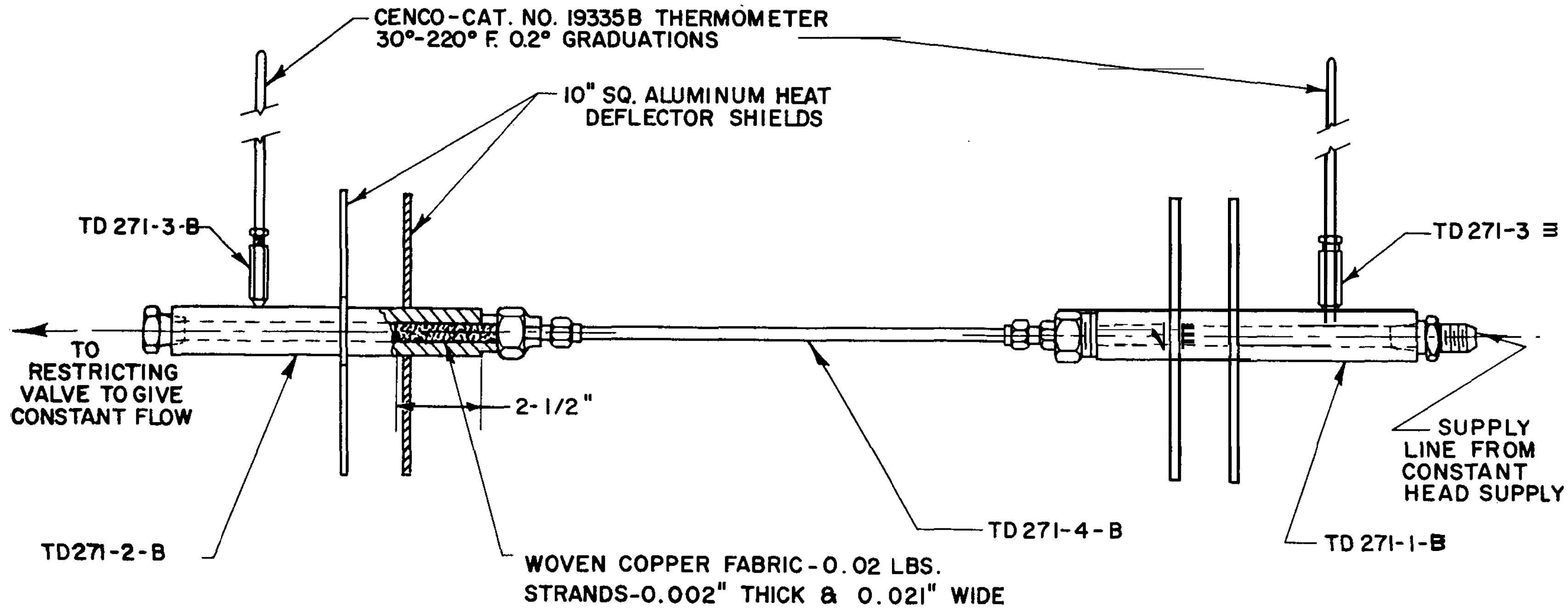


ASSEMBLY

**B.T.U. TRANSFER DEVICE FOR
TORCH STANDARDIZATION**

Civil Aeronautics Administration
Technical Development and Evaluation Center
Indianapolis, Ind.

Drawing No. TD271—1A—B



ASSEMBLY

B.T.U. TRANSFER DEVICE FOR TORCH STANDARDIZATION

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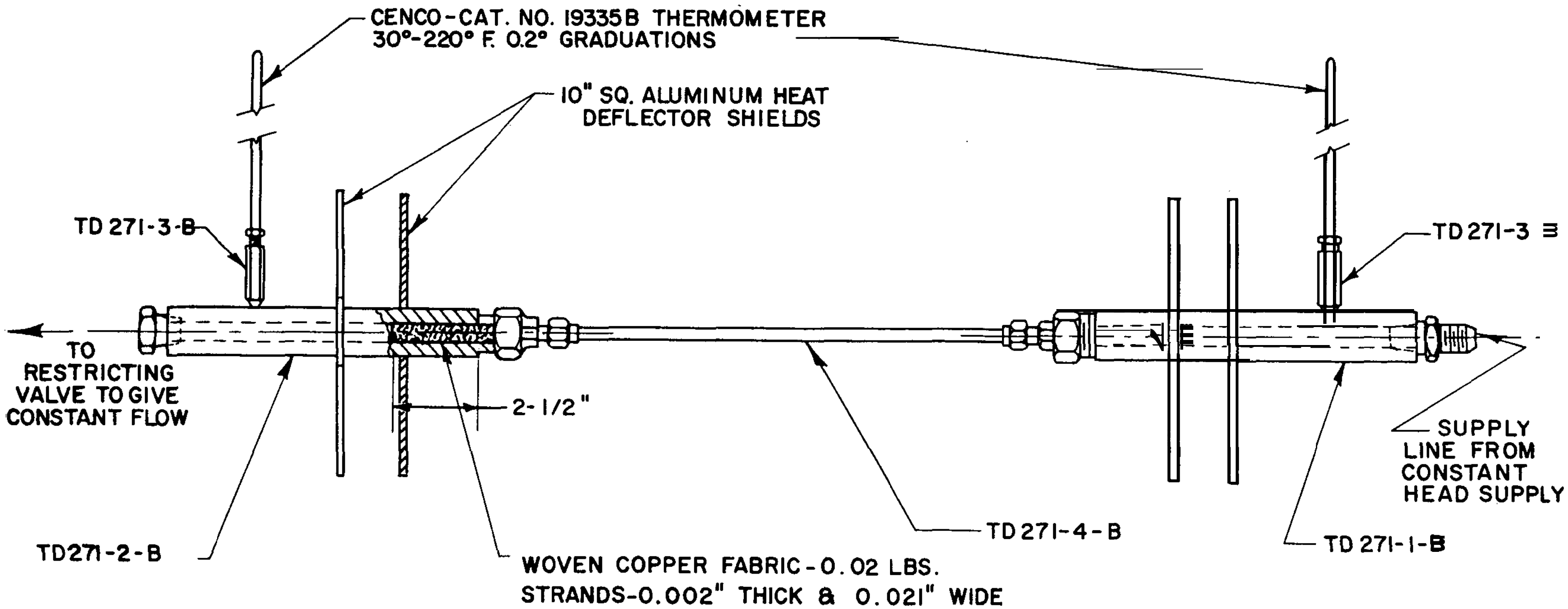


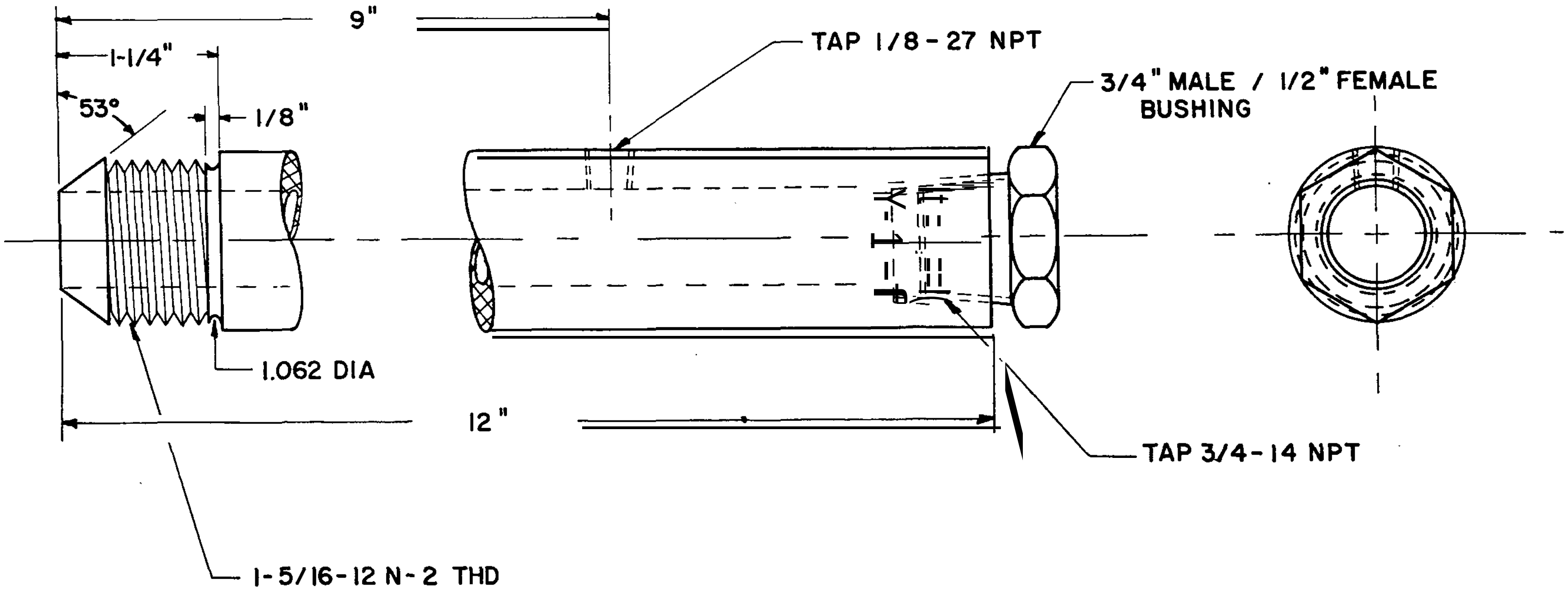
ASSEMBLY

B.T.U. TRANSFER DEVICE FOR TORCH STANDARDIZATION

Civil Aeronautics Administration
Technical Development and Evaluation Center
Indianapolis, Ind.

Drawing No. TD271—1A—B

MATL. — DILECTO ASBESTOS BASE TUBING, AA—79
Made by Continental-Diamond Fiber Corp., Newark, Del.
1 7/16'' O.D. x 13/16'' I.D. x 12''



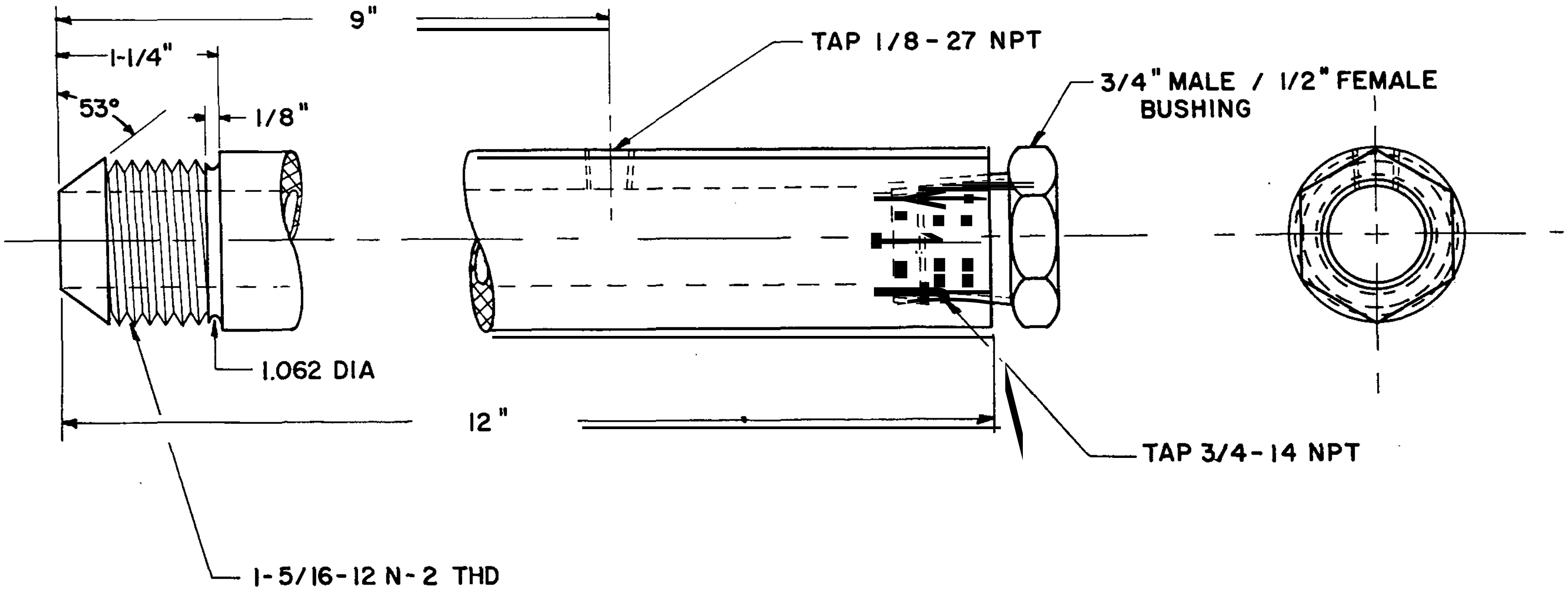
OUTLET TUBE

B.T.U. TRANSFER DEVICE FOR TORCH STANDARDIZATION

Civil Aeronautics Administration
Technical Development and Evaluation Center
Indianapolis, Ind.

Drawing No. TD271—2—B

MATL. — DILECTO ASBESTOS BASE TUBING, AA—79
Made by Continental-Diamond Fiber Corp., Newark, Del.
1 7/16'' O.D. x 13/16'' I.D. x 12''



OUTLET TUBE

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Civil Aeronautics Administration
Technical Development and Evaluation Center
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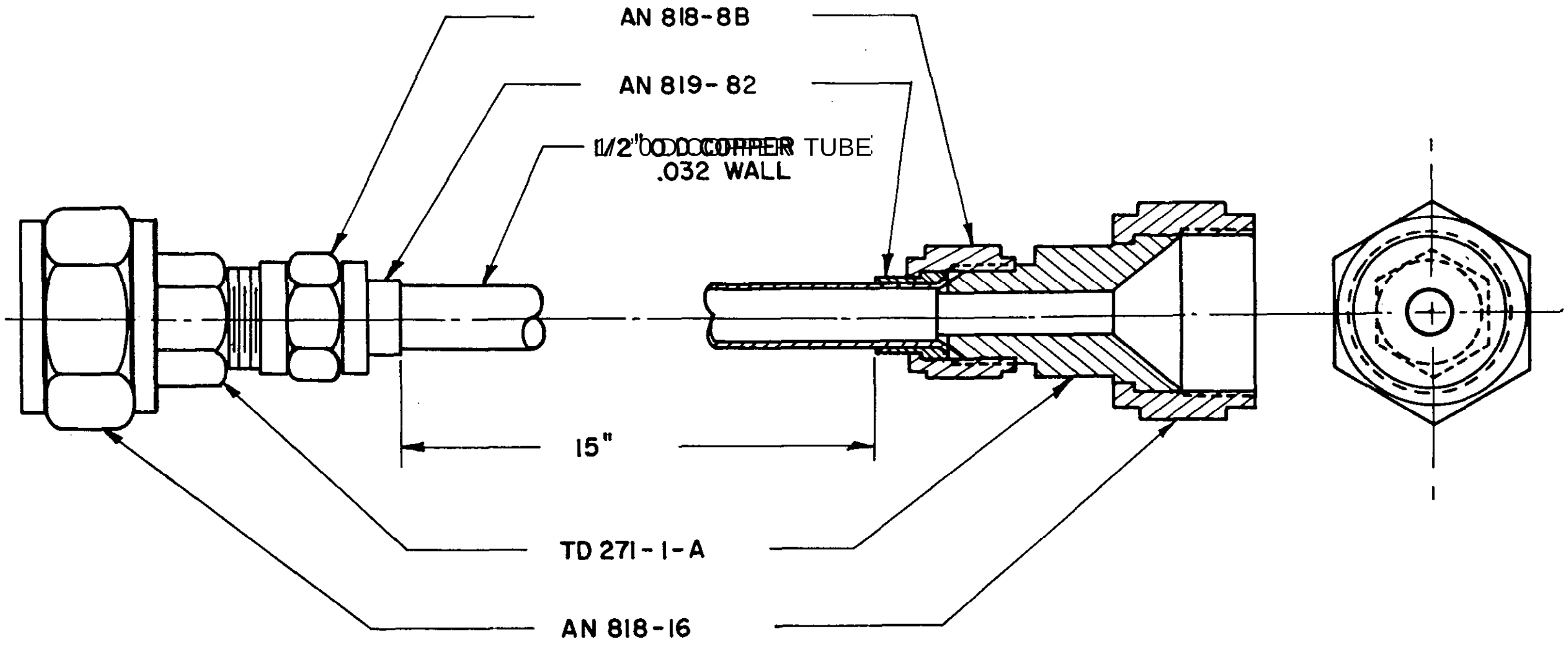
Drawing No. TD271—2—B

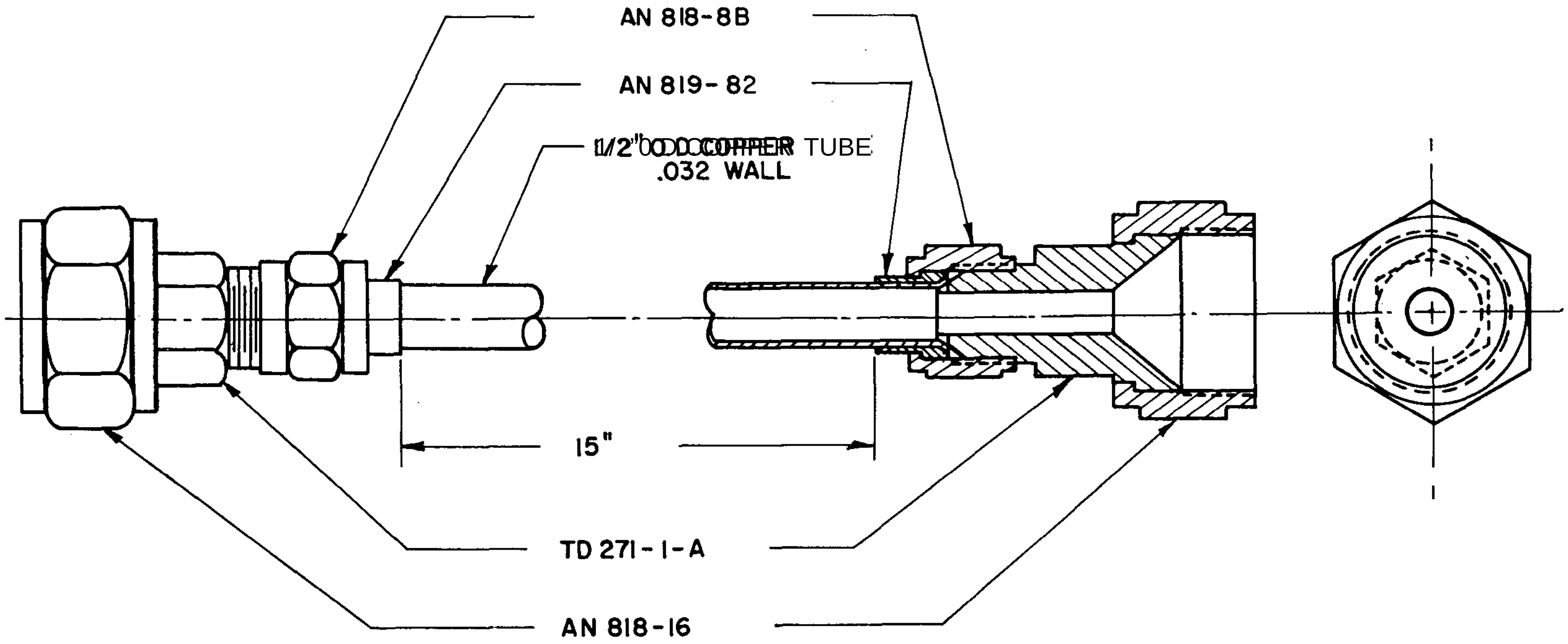


TEST SPECIMEN

B.T.U. TRANSFER DEVICE FOR
TORCH STANDARDIZATION

Civil Aeronautics Administration
Technical Development and Evaluation Center
Indianapolis, Ind.

Drawing No. TD271-4-B



TEST SPECIMEN

B.T.U. TRANSFER DEVICE FOR
TORCH STANDARDIZATION

Civil Aeronautics Administration
Technical Development and Evaluation Center
Indianapolis, Ind.

Drawing No. TD271-1-B

4. The air tube diameter was decreased to 2 1/2 inches starting 1 1/2 inches forward of the fuel nozzle tip. The reducing cone is shown in figure 7.

5. Two 1/16-inch-thick by 3/4-inch-wide stainless steel fuel deflectors were installed at the 3 and 9 o'clock positions with their ends 5/8-inch from the fuel nozzle centerline and 3 /4-inch forward of the fuel nozzle tip. A l-inch wide stainless steel fuel deflector (1/16-inch thick) was installed at the 12 o'clock position with its edge 3/4 inch forward of the fuel nozzle tip and 3/4-inch above fuel nozzle centerline.

6. A static pressure port was installed l-inch forward of the air tube mounting flange.

7. A 12 1/2-inch burner extension (reference 1) shown in figure 8 was added to the end of the burner air tube. The extension was installed on the air tube so that the wide end was 10 inches beyond the end of the air tube. The air pressure was adjusted to indicate 0.37 inch H20 air tube pressure.

The temperature profile obtained with this burner configuration is shown in figure 9. A heat transfer rate of 4, 545 B. t. u. /hr. to the 1/2-inch tube was obtained as shown in table 1, and the total thermal energy measured an average range from 9.3 to 11.2 B. t. u. /ft /sec. Oxygen volumetric concentration within the flame ranged from 6.5 percent to 8.5 percent.

<u>STEWART-WARNER MODEL HPR 250,</u> manufactured by the Stewart-Warner Corporation, Heating and Air Conditioning Division, Lebanon, Indiana 46052, figures 10 and 11, was modified in the following manner to produce a diffused 6-inch (vertical) by 11-inch (horizontal) size flame with homogeneous temperature gradient:

1. An 80 fuel nozzle rated at 2.25 gal/hr. and pressure adjusted to 95 psig and delivering 2.04 gal/hr. was installed.

2. The air cone assembly was removed.

3. The air tube diameter was reduced to 2 1/2 inches starting 1 1/2 inches forward of the fuel nozzle tip with the addition of the reducing cone shown in figure 7.

4. Four 1/16-inch by 3/4-inch stainless steel fuel deflectors were mounted on the reducing cone at 3, 6, 9 and 12 o'clock positions. The deflector edges were 3/4-inch from the fuel nozzle centerline and 3/4-inch forward of the fuel nozzle tip.

5. A static air-pressure port was installed l-inch forward of the burner tube mounting flange.

6. A 12 1/2-inch burner extention (reference 1) shown in figure 8 was added to the end of the burner air tube. The extension was installed so that the wide end was 10 inches from beyond the end of the air tube. Air pressure in the tube was adjusted to 0.14 inch H_2O.

The temperature profile shown in figure 12 was obtained with this configuration, and a heat transfer rate of 4,646 B. t. u. /hr. to the 1/2-inch tube was obtained as shown in table 1. The total thermal energy measured an average range from 9.3 to 10.1 B. t. u. /ft^2/sec. The O_2 concentration, measured through the horizontal centerline of the flame, fluctuated from 9.2 percent to 9.5 percent in the flame center. Two inches from each side, the O_2 concentration increased to 11 percent and 15 percent, respectively. This burner had the tendency to burn richer at the outer edges of the flame, as observed visually and confirmed by O_2 concentration measurements.

<u>STEWART-WARNER MODEL FR-600,</u> as shown in figures 13 and 14, was modified in the following manner to produce a diffused 6-inch (vertical) by 11-inch (horizontal) size flame with homogeneous temperature gradient.

1. An 80° fuel nozzle rated at 2.25 gal/hr. and pressure adjusted to deliver 2.03 gal/hr. at 100 psig was installed.

2. The flame retention hood assembly was removed.

3. The air tube diameter was decreased to 2 1/2 inches starting 1 1/2 inches forward of fuel nozzle tip, with the reducing cone as shown in figure 7.

4. Four 1/16-inch by 3/4-inch stainless steel deflectors were mounted on the reducing cone at 3, 6, 9, and 12 o'clock positions. The deflector edges were adjusted to within 3/4-inch from the fuel nozzle centerline and 1 1/2-inch forward of the fuel nozzle.

4. Four 1/16-inch by 3/4-inch stainless steel fuel deflectors were mounted on the reducing cone at 3, 6, 9 and 12 o'clock positions. The deflector edges were 3/4-inch from the fuel nozzle centerline and 3/4-inch forward of the fuel nozzle tip.

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1430	1749	1721	1847	1820	1858	1887	1914	1822	1717	1418
1778	1747	1891	1980	1988	1990	1994	1994	1947	1818	1718
1789	1847	1944	1997	1987	1978	1948	1975	1983	1915	1669
1179	1682	1882	1843	1775	1750	1709	1703	1883	1883	1401
0740	1325	1597	1398	1238	1247	1064	1186	1550	1510	0719
0673	0647	0642	0596	0565	0569	0630	0649	0730	0553	0420

1"

1"

------ = 1800°F

FIGURE 4. LENNOX OB-32 TEMPERATURE PROFILE

1430	1749	1721	1847	1820	1858	1887	1914	1822	1717	1418
1778	1747	1891	1980	1988	1990	1994	1994	1947	1818	1718
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1"

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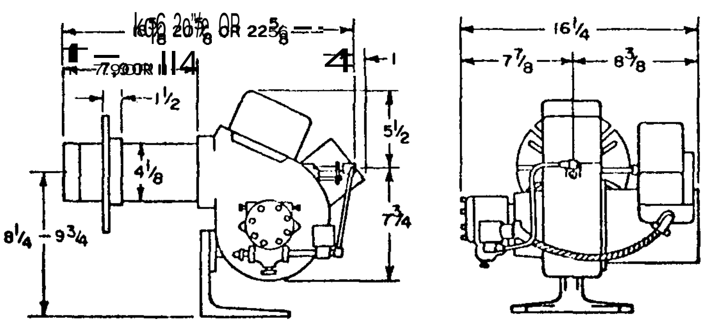


FIGURE 6. CARLIN 200 CRD BURNER

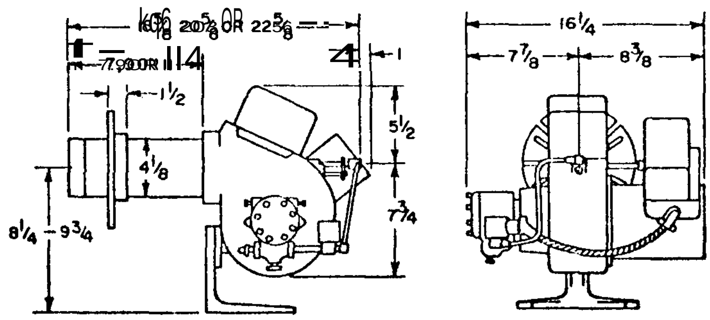


FIGURE **6. CARLIN 200 CRD** BURNER

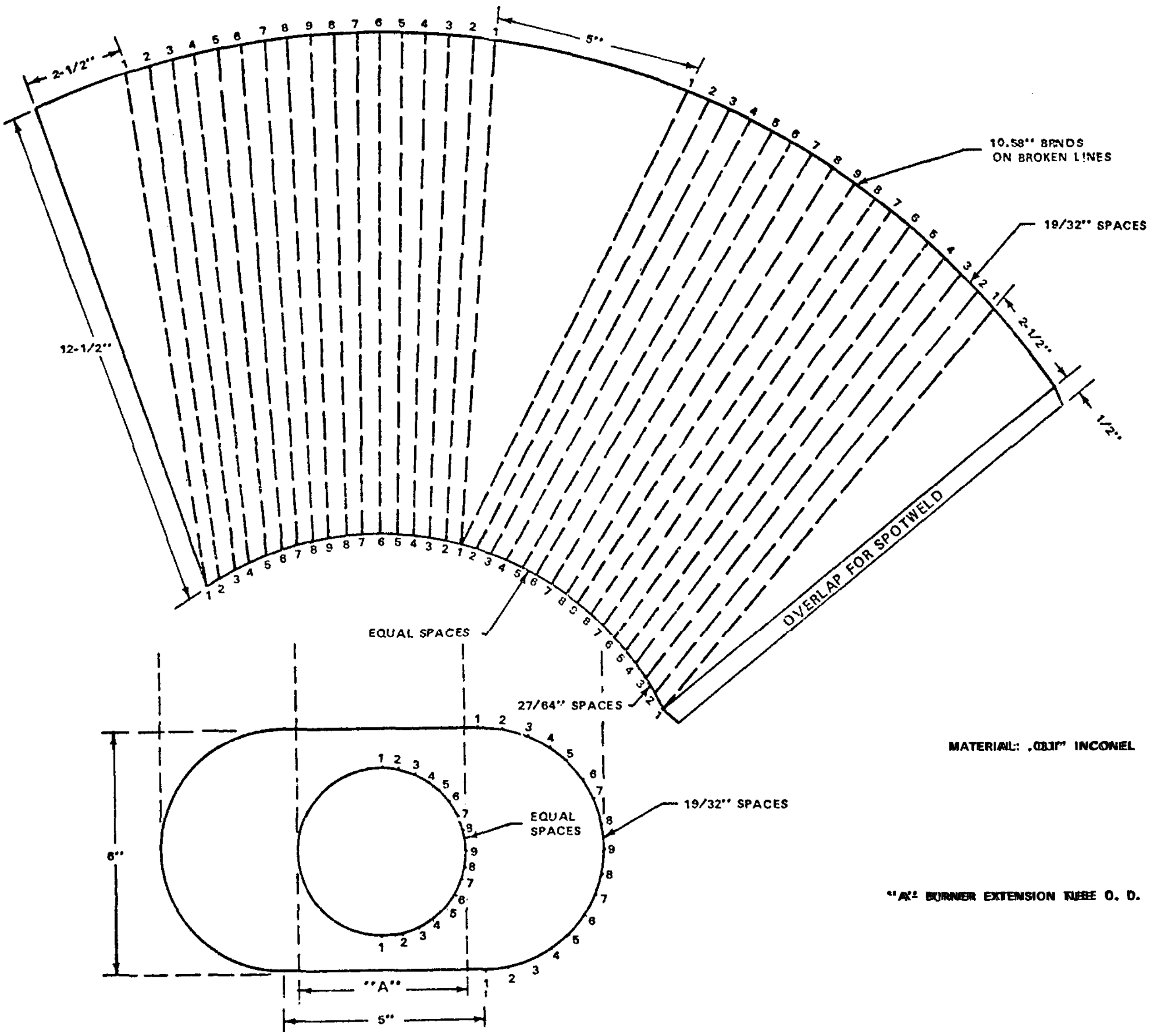


FIGURE 8. BURNER TUBE EXTENSION

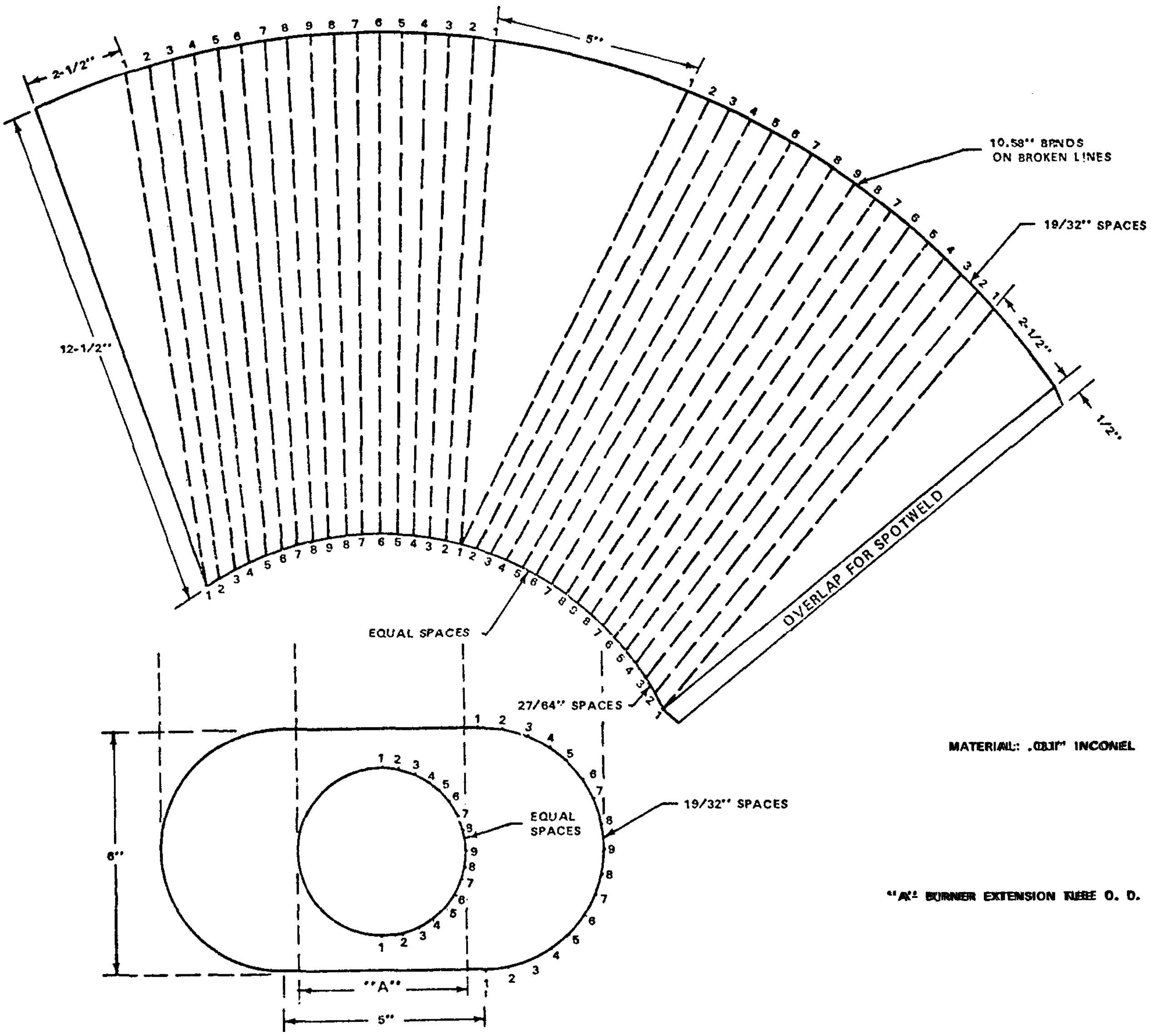
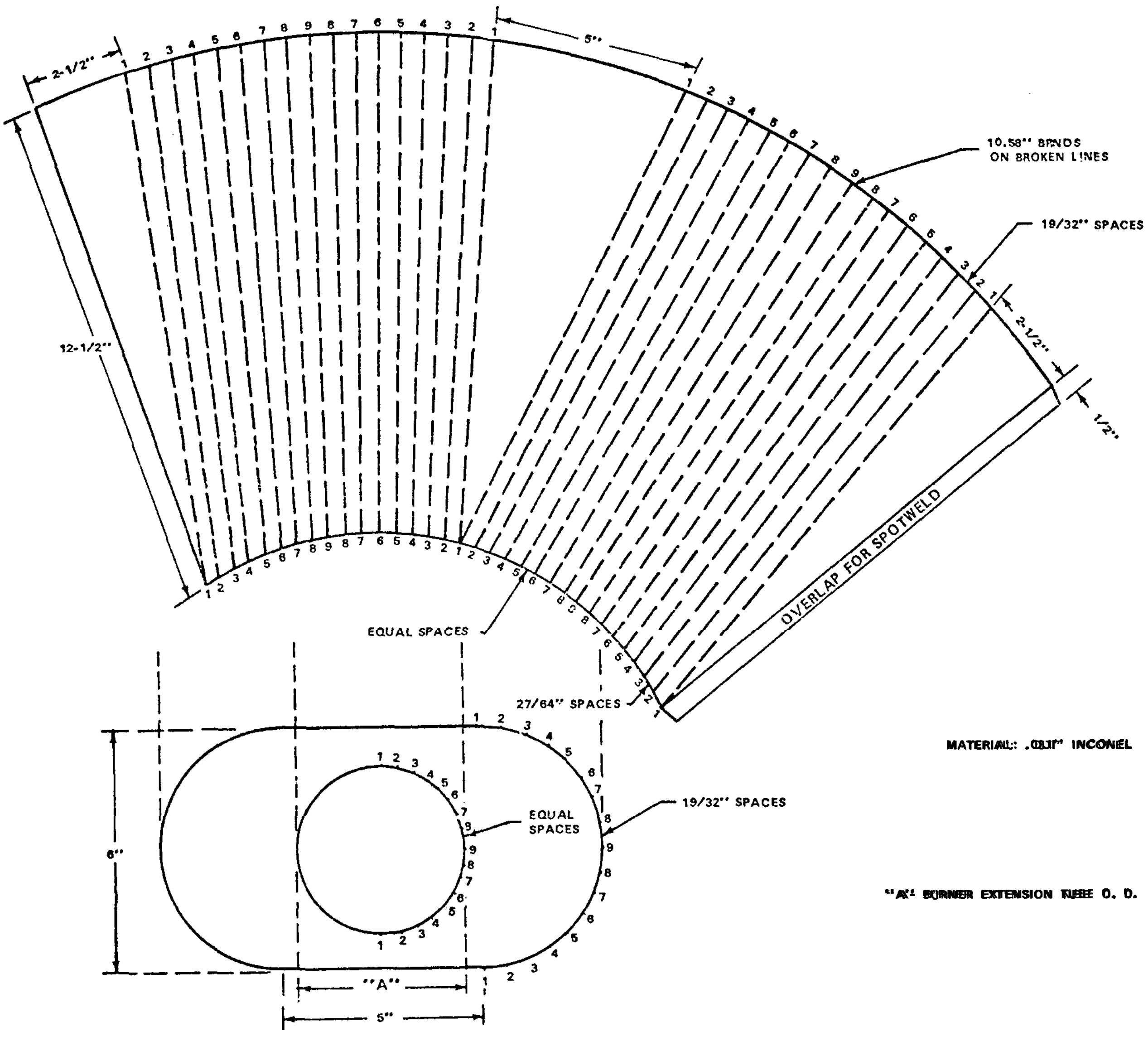


FIGURE 8. BURNER TUBE EXTENSION



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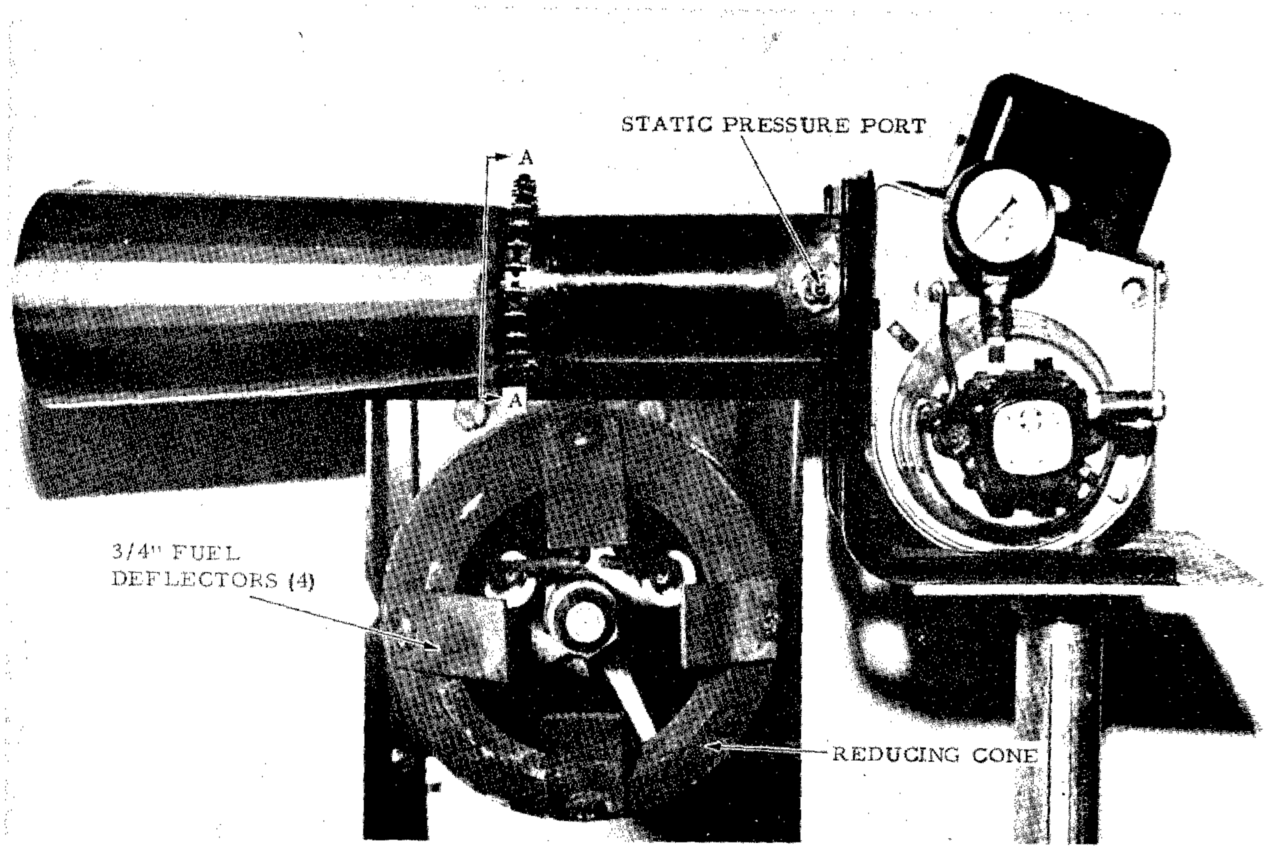


FIGURE 10. STEWART-WARNER HPR-250 CONVERSION OIL BURNER

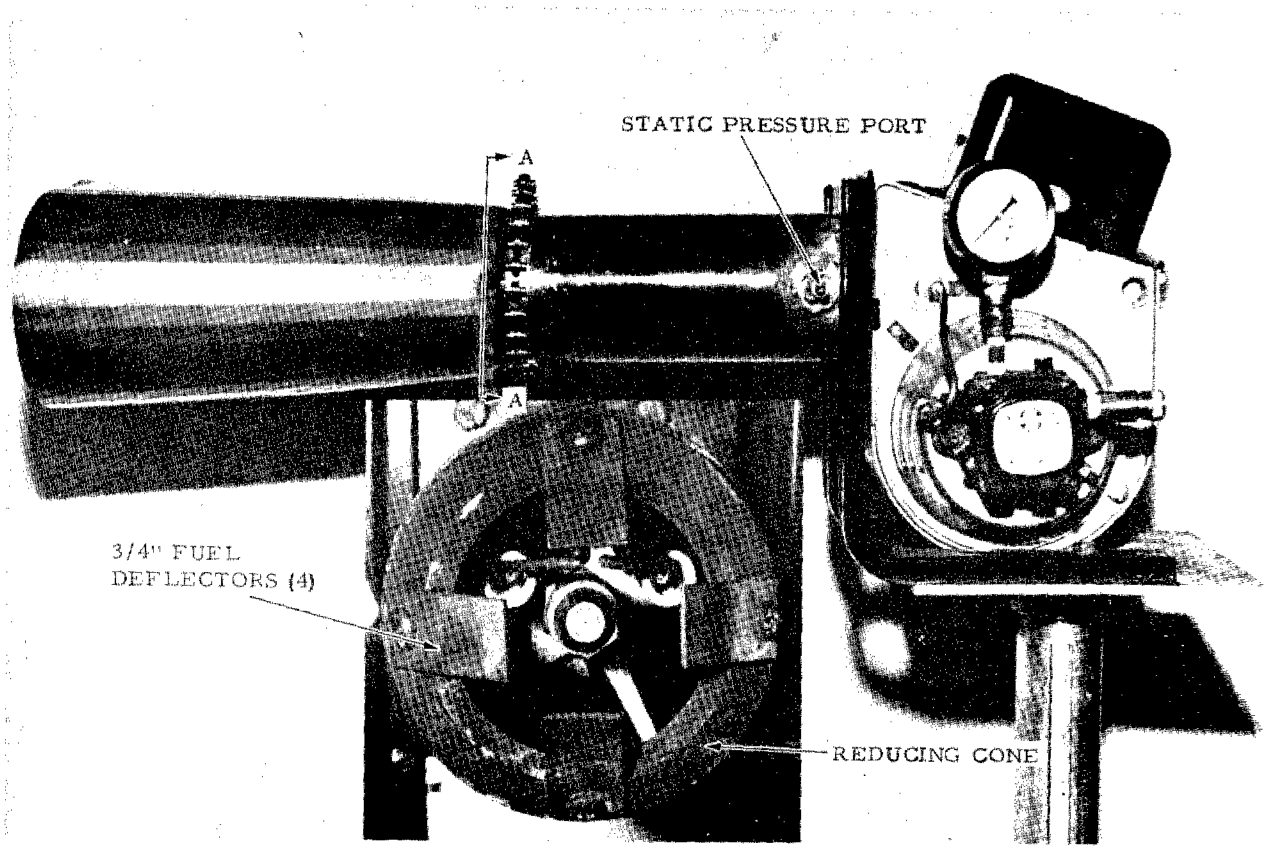
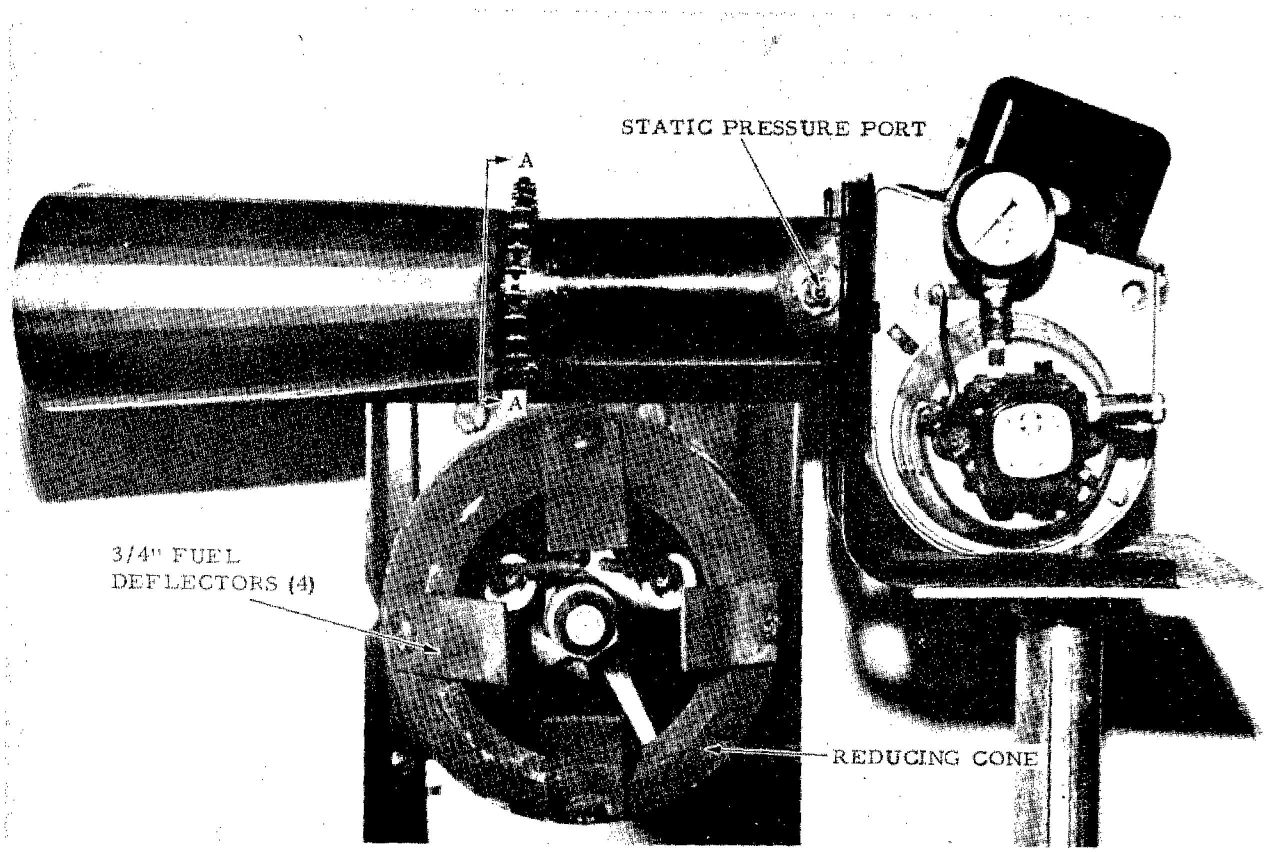


FIGURE 10. STEWART-WARNER HPR-250 CONVERSION OIL BURNER



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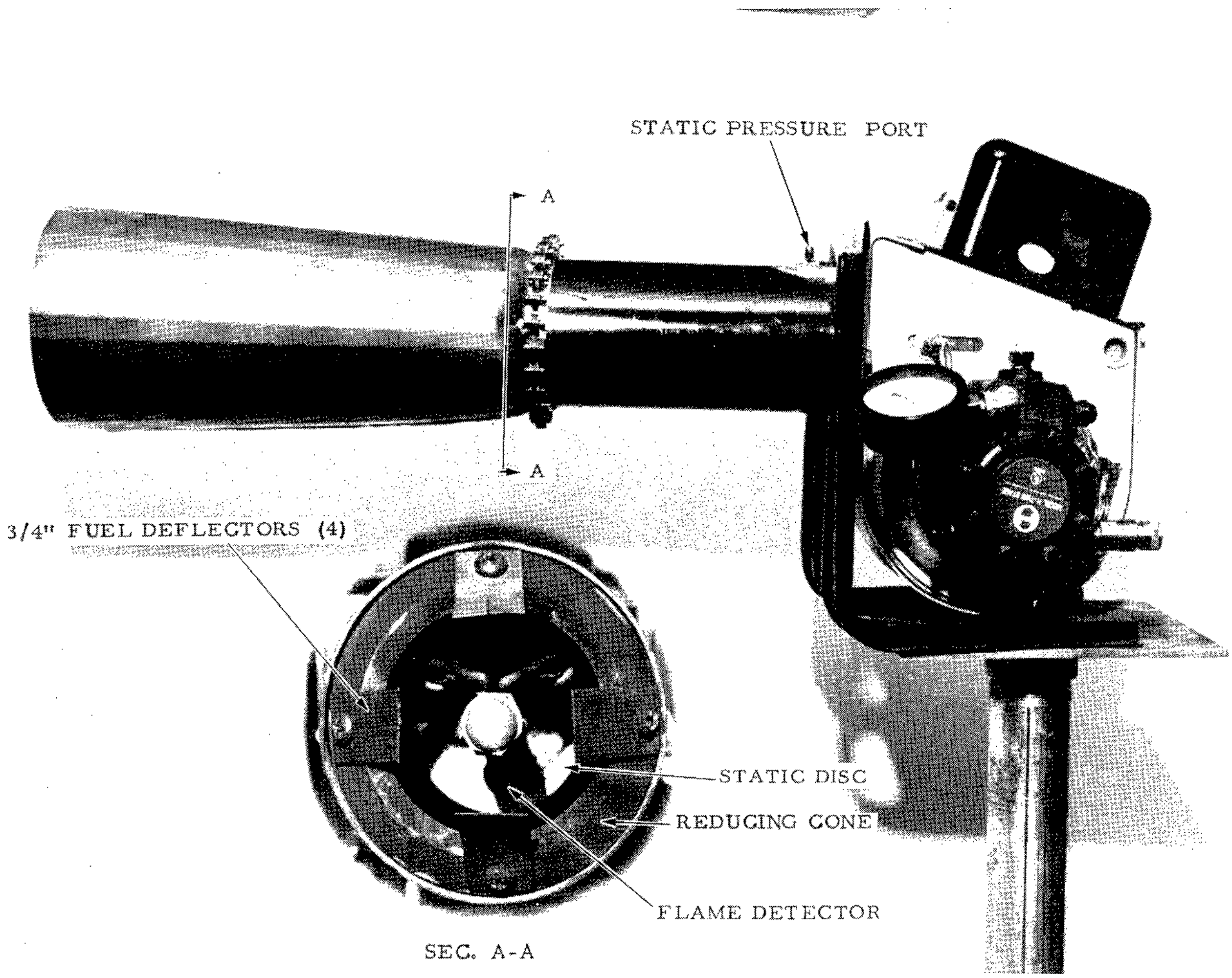

FIGURE 13. STEWART-WARNER FR-600 CONVERSION OIL BURNER

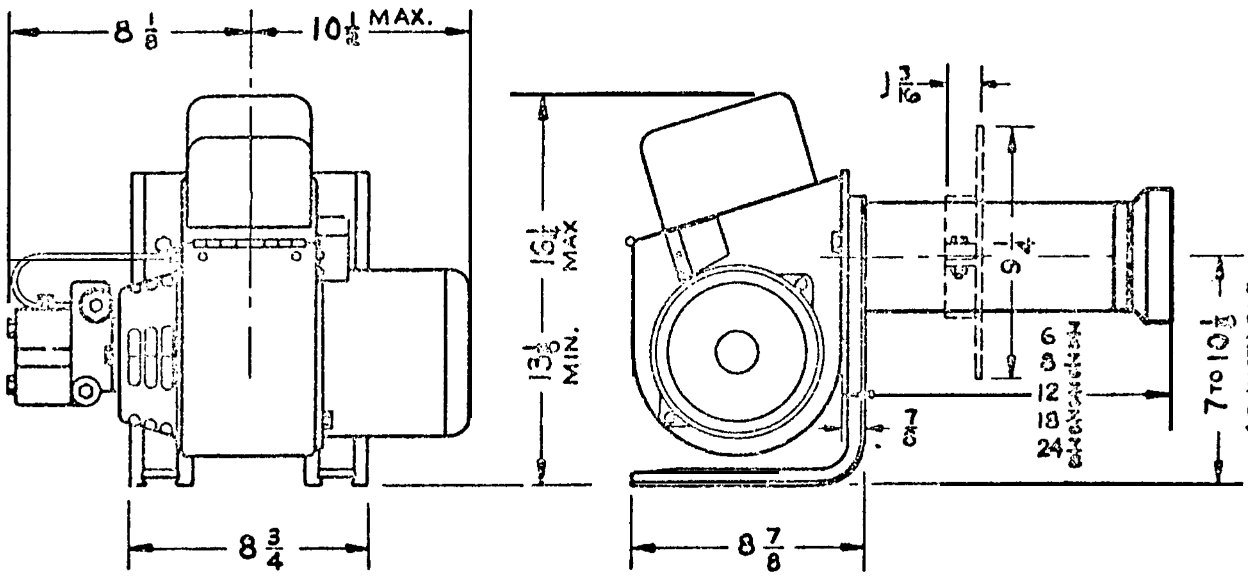

FIGURE 14. STEWART-WARNER FR-600 BURNER

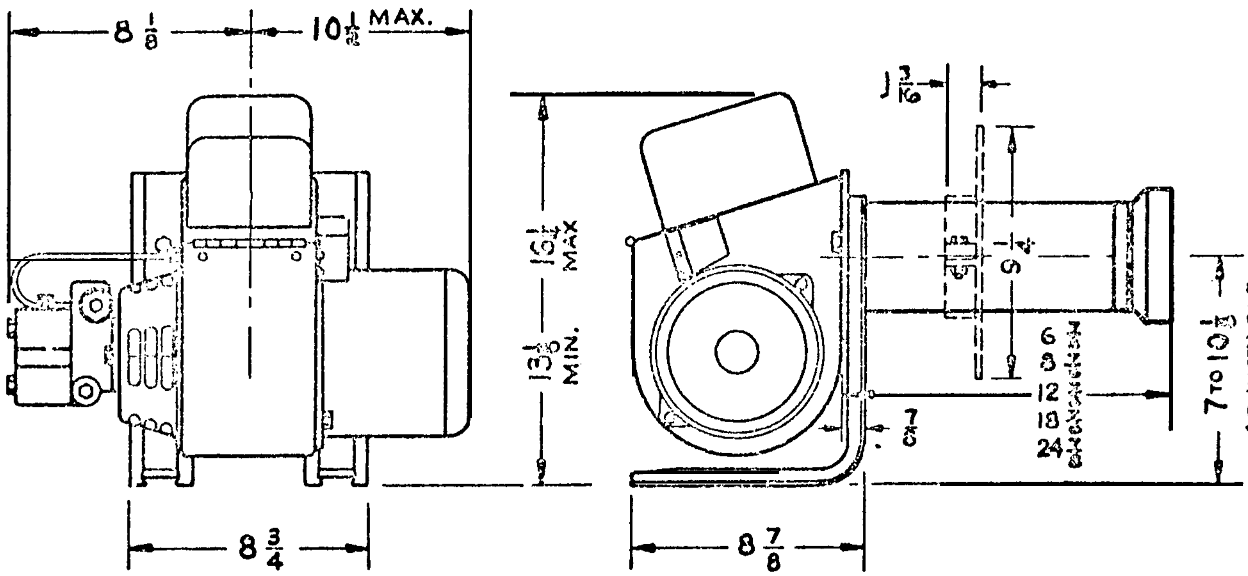

FIGURE 14. STEWART-WARNER FR-600 BURNER

Reference

1. Federal Aviation Administration: Report No. FAA-RD-76-213, Reevaluation of Burner Characteristics for Fire Resistance Tests, James E. Demaree, January 1977.

2. Society of Automotive Engineers: Report AS 1055B, Fire Testing of Flexible Hose, Tube Assemblies, Coils, Fittings and Similar System Components.

3. Society of Automotive Engineers : Report AS 1377, Fire Test Equipment for Flexible Hose and Tube Assemblies

4. Society of Automotive Engineers: Report G3-75-2, (SC10/DIS DDD), Fire Testing, Components, Fluid System, General Specifications for

POWER PLANT ENGINEERING REPORT NO. 3A

STANDARD FIRE TEST APPARATUS AND PROCEDURE

(FOR FLEXIBLE HOSE ASSEMBLIES)

REVISED

MARCH 1978

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Flight Standards Service
Washington, D.C. 20591